# Rheology of Bridged Wormlike Micelles



Nakaya, Kaori; Ligoure, Christian; Ramos, Laurence

研究会報告

# Rheology of Bridged Wormlike Micelles

Dept. of Physics, Ochanomizu Univ. Kaori Nakaya*

LCVN, Univ. Montpellier 2. Christian Ligoure and Laurence Ramos

ひも状ミセル間をテレケリックコポリマーでブリッジした系の線形領域におけるレオロジー挙動について研究を行った。その結果、系の粘弾性は、ミセル自身の絡み合い効果とテレケリックコポリマーがひも状ミセルをブリッジした効果との２モードで記述できることが明らかになった。

We have investigated the linear rheological properties of a new type of transient network, i.e. *bridged wormlike micelles* (*BWM)* which is obained by adding a small amount of telechelic copolymers in a solution of long an flexible entangled surfactants cylinders (wormlike micelles WM) shown by previous structural investigations (Ramos and Ligoure in preparation) the hydrophobic ends (stickers) of the telechelic copolymers anchor in the cylinders while the hydrophilic central blocks are swollen in the solvent. Telechelic copolymers can either link with sliding junctions two neighboring entangled surfactant cylinders (bridge configuration) or decorate them (loop configuration). Each sample is characterized by two parameters: the surfactant concentration $\phi$ which dictates the mesh size of the entangled cylinders network and the stickers to surfactant molar ratio $\beta$ which monitors the amount of bridges between the micelles. With have surveyed the linear viscoelastic properties of the mixed system at constant temperature $T$=30°C by varying both $\phi$ at constant $\beta$ or $\beta$ at constant $\phi$. For comparison, we performed the same experiments on naked WM and hairy WM decorated by amphiphilic copolymers (half of a telechelic chain with a single sticker) with the same surfactant concentration and amount of sticker.

The viscoelastic properties of the material can be described by two almost ideal Maxwell relaxators mounted in parallel, which is the signature of a double transient network (Figure 1). The slow mode ($\tau_{slow}$) with the lower elastic modulus $G_{slow}$ is related to the viscoelastic properties of the transient network of entangled micelles and is slightly modified by the amount of bridging. The fast mode ($\tau_{fast} << \tau_{slow}$) with the higher elastic modulus ($G_{fast} >> G_{slow}$) is due to telechelic active chains. Indeed we have checked that hairy WM systems exhibit almost the same single ideal Maxwell relaxator viscoelastic as naked WM(Figure 2). Interestingly we show that telechelic chains can form a transient network at very low concentration (no percolation), contrarily to the more classical situation of a network formed by telechelic chains in solution, because the network of wormlike micelles can transmit the stress of even very diluted

* E-mail: nakaya@phys.ocha.ac.jp

telechelic elastic chains along the entire sample. Finally we show that $G_{fast}$ is proportional to the number density of active chains (bridges) for high enough surfactant concentration $\phi$ (above which the fraction of bridge versus loops is independent of $\phi$).

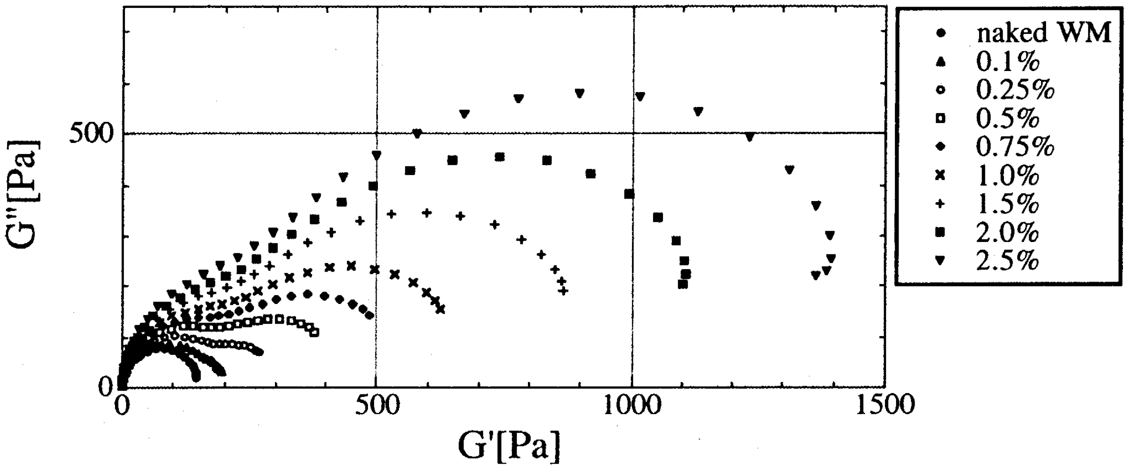


Figure 1 Cole-cole plot of *BWM* changing $\beta$ at $\phi$=9%.

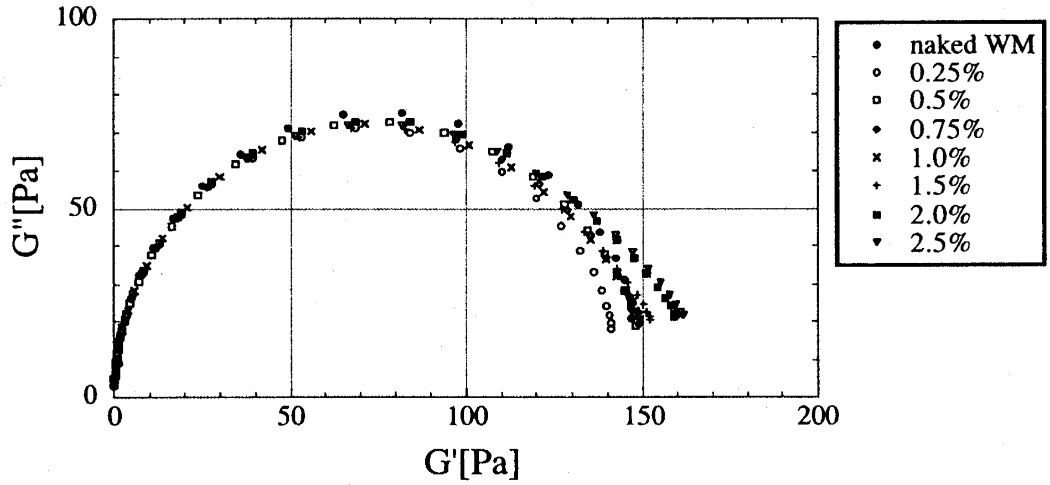


Figure 2 Cole-cole plot of hairy WM changing $\beta$ at $\phi$=9%.